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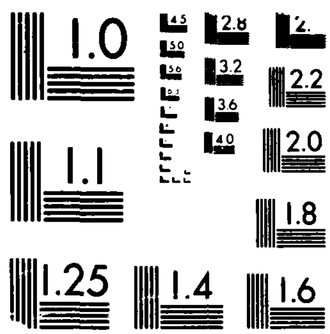

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ABSTRACT

Different test methods give widely varying values of water vapour resistance for materials with hydrophilic coatings. An experiment was performed confirming that anomalous diffusion occurs in such materials, providing a mechanism by which to explain the various test results.

RÉSUMÉ

Des matériaux possédant des revêtements hydrophiliques donnent des valeurs de perméabilité à la vapeur d'eau qui varient énormément en fonction de la procédure expérimentale utilisée. Une expérience fut faite afin de confirmer que le processus de diffusion dans ce type de matériel dévie de la normalité. Le mécanisme de diffusion obtenu est utilisé pour expliquer les résultats tirés des autres méthodes expérimentales.

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1.0 INTRODUCTION

An earlier study had been carried out to evaluate several methods of measuring the water-vapour resistance of coated, waterproof, but water-vapour permeable fabrics. The results, which are reported elsewhere (1), were inconsistent. It was found that the resistance values of individual fabrics and the ranking of the fabric within the series of fabrics varied from method to method. When the results and methods were examined, it became apparent that the fabrics with hydrophilic coatings had water-vapour resistance values which were humidity-dependent. The water-vapour resistance of such fabrics was high when the fabric was tested using a method in which the fabric was in relatively dry air. Conversely, the water-vapour resistance was low when the fabric was tested by a method in which the fabric was adjacent to a wet surface.

This paper reports the experiment carried out to examine the effect of relative humidity on the water-vapour resistance of a water-vapour permeable coated fabric. Only one experiment was carried out because, upon its completion, it was discovered that other workers had independently formulated and tested the same hypothesis with similar results ~~(2)~~. (Canada).

2.0 METHOD

Three plexiglass rings, 11.6 mm thick were made to fit the test area of the DREO (3) apparatus. A schematic diagram is shown in Figure 1. The circular hole in each was filled with polyester batting to reduce air movement. The fibre volume was less than 1%. The resistances of these batting-filled rings, and of combinations are given in Table I. The mean resistance of a spacer ring is 11.6 ± 0.5 mm of equivalent still air (E.S.A.) which agrees nicely with the average ring thickness.

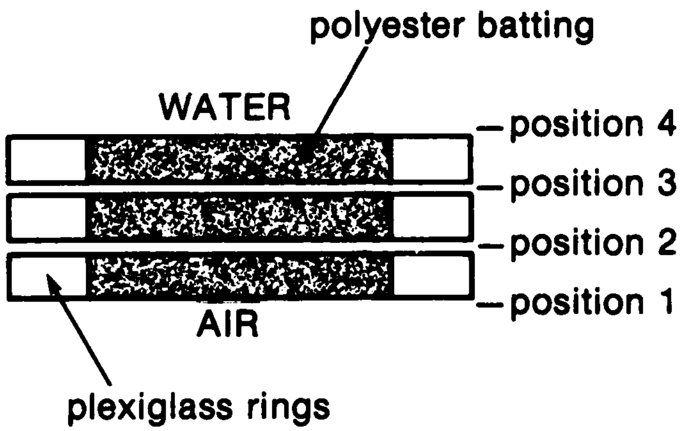

Figure 1: Cross-Sectional Schematic Diagram of Plexiglass Rings & Fabric Positions

TABLE I

Resistances of Spacer Rings

Ring No.	Resistance (mm E.S.A.) ± S.D.
1	12.0 ± 0.2
2	11.1 ± 0.7
3	11.6 ± 1.1
1 + 2	23.7 ± 4.5
1 + 2 + 3	35.6 ± 0.7
2 + 3	23.0 ± 5.9

The test sample was a three layer laminate of camouflage-printed polyester/cotton fabric, a polytetrafluoroethylene film (Goretex II), and a nylon tricot. It was 0.41 mm thick and had a mass of 0.17 kg per square metre. Goretex II has a hydrophilic coating applied to the porous PTFE film to protect it from sweat poisoning.

The effect of relative humidity (RH) on the sample resistance was determined by measuring the total resistance of the spacer rings plus the sample, with the sample at various locations in the stack. When the sample was between the dry side of the apparatus and the stack of three rings, the

RH at the level of the sample was at a minimum (Position 1). When it was between the stack of three rings and the water reservoir of the apparatus, the RH was at a maximum (Position 4). When the sample was between rings 1 and 2 and between 2 and 3 (Position 2,3) the RH was at some intermediate value which could be determined approximately from the relative resistances of the sample and the rings. It was assumed that the RH at the dry and wet ends was 0% and 100% respectively, and that the apparatus resistance was divided evenly between its wet and dry faces. The sample was conditioned to 65% RH before testing.

3.0 RESULTS AND DISCUSSION

The results are listed in Table II.

TABLE II

Resistance of Sample at Calculated Average Relative Humidities

Position	RH (%)	Resistance (mm air eq)
1	30	45 ± 15
2	44	45 ± 14
3	59	26 ± 15
4	88	3 ± 5
No spacers	50	17 ± 1

There is an obvious decrease of resistance to water vapour diffusion with an increase in relative humidity. Such behaviour has been previously noted by Fourt and Harris (4). In their experiments, the resistance of cellophane varied from 1.6 mm when tested over water at about 75% RH, to 48 mm when measured over a dessicant at an RH of about 40%. The dependence of diffusion rates on concentration is well established for many polymers (5). Similar behaviour has been reported for human skin (6) and keratin (7). This diffusion is referred to as non-Fickian or anomalous

diffusion. The diffusion constant appears to depend on the concentration of the vapour in the material. This may be a simplification of the process, as molecules do not spend all of their time diffusing, but are adsorbed by the molecules of the barrier for periods of time (8). Keighley (9) noted that the "breathability" of certain rainwear fabrics appeared to increase in wet conditions. It is possible that other hydrophilic materials, such as leather are similarly affected.

4.0 CONCLUSION

The results confirm, for materials with hydrophilic coatings, the value of water-vapour diffusion resistance obtained from direct measurement will depend on the RH at which the measurement is made. Care should be taken when attempting to apply the results of such measurements to conditions which differ from those of the test.

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